Movements of Tagged Lobsters Released on the Continental Shelf from Georges Bank to Baccaro Bank, 1971-73

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Fisheries and Aquatic Sciences 1288

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MOVEMENTS OF TAGGED LOBSTERS RELEASED ON THE CONTINENTAL SHELF FROM GEORGES BANK TO BACCARO BANK, 1971-73.

by

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ABSTRACT

Campbell, A., D. E. Graham, H. J. MacNichol, and A. M. Williamson. 1984. Movements of tagged lobsters released on the Continental Shelf from Georges Bank to Baccaro Bank, 1971-73. Can. Tech. Rep. Fish. Aquat. Sci. 1288: iii + 16 p.

A total of 1309 lobsters (Homarus americanus) were tagged and released in offshore areas from Welker Canyon to the Continental Slope off Baccaro Bank during 1971-73. Of the total tags released, 13.2% were recaptured with only 150 lobsters with known recapture locations. Although most (71.8%) recaptures were made within 1 yr of release, 1.3% of lobsters were at liberty for 8-9 yr prior to recapture. Of the total recaptured lobsters 42.0% moved <18.5 km and 12.7% moved >92.6 km from the release areas. The greatest straight-line distance moved (346.9 km) was recorded for a 117-mm carapace length (at release) female that traveled from the Continental Slope near Browns Bank to east of Welker Canyon in 5.1 yr. There were seasonal trends in mean depths of recapture with the deeper recapture depths occurring during January-June and the shallower depths of recapture during July-December of each year. The results of this study support other tagging studies that showed offshore mature lobsters moving large distances, and with some lobsters showing seasonal shallow-to-deep movements.

RÉSUMÉ

Campbell, A., D. E. Graham, H. J. MacNichol, and A. M. Williamson. 1984. Movements of tagged lobsters released on the Continental Shelf from Georges Bank to Baccaro Bank, 1971-73. Can. Tech. Rep. Fish. Aquat. Sci. 1288: iii + 16 p.

De 1971 à 1973, un total de 1 309 homards (Homarus americanus) ont été marqués et remis en liberté dans les régions du large, entre le canyon Welker et la pente continentale, au large du banc Baccaro. De tous les homards libérés, 13,2% ont été recapturés, l'endroit de la recapture étant connu pour seulement 150 sujets. Bien que la plupart (71,8%) aient été recapturés moins d'un an après leur mise en liberté, 1,3% étaient demeurés en liberté de 8 à 9 ans avant d'être recapturés. Parmi ceux qui ont été recapturés, 42,0% avaient parcouru moins de 18,5 km et 12,7% plus de 92,6 km de la zone de marquage. La plus grande distance (en ligne droite), soit 346,9 km, a été parcourue par une femelle qui mesurait, au moment de sa mise en liberté, 117 mm de longueur de carapace; ce sujet s'était déplacé depuis la plate-forme continentale, près du banc Browns, jusqu'à l'est du canyon Welker, en l'espace de 5,1 ans. On a observé des tendances saisonnières des profondeurs de recapture moyennes, les plus grandes profondeurs étant celles de janvier à juin, et les plus faibles de juillet à décembre de chaque année. Les résultats de cette étude confirment ceux d'autres marquages, qui ont démontré que les homards matures des eaux du large parcouraient de grandes distances et que certains sujets se déplaçaient saisonnièrement des eaux peu profondes vers les eaux profondes.

INTRODUCTION

The biology and fishery of the American lobster (Homarus americanus) in the offshore areas of New England and southwestern Nova Scotia have been studied since the 1940's (see reviews by Wilder 1970; Burns et al. 1979; Cooper and Uzmann 1980; Fogarty et al. 1982; Pezzack and Duggan 1983). Since the mid-1960's Canadian scientists have investigated lobster distribution, biology and fishery on Georges Bank and Browns Bank to Banquereau Bank (McKenzie 1966; Graham and Wilder 1966; Wilson and Wilder 1967; Wilder and Graham 1973; Wilder 1974; Stasko 1978; Stasko and Campbell 1980; Stasko and Pye 1980a, b; Stasko and Gordon 1983; Pezzack 1983; Pezzack and Duggan 1983). However, little is known of the movements of lobsters tagged during the early Canadian investigations in these offshore areas. Although extensive seasonal migrations of tagged lobsters in the New England Continental Shelf region have been demonstrated (Saila and Flowers 1968; Cooper and Uzmann 1971; Uzmann et al. 1977), there have been only a few fragmentary reports of lobster tagging studies on the Nova Scotia Continental Shelf region (McKenzie 1966; Wilson and Wilder 1967; Wilder and Graham 1973; Wilder 1974; Stasko and Graham 1976). During 1971-73, when the Canadian offshore lobster fishery was beginning (Pezzack and Duggan 1983), 1309 lobsters were tagged and released in six general areas, including Lydonia Canyon, Georges and Browns Banks. Despite a few summary reports (Wilder and Graham 1973; Stasko 1980), there has not been a comprehensive examination of the lobster movements tagged during 1971-73. The purpose of this report is to present an analysis of the tag release-recapture information and consider the implications of seasonal and long-term movements of lobsters tagged during 1971-73.

MATERIALS AND METHODS

During September 1971, to July 1973, 1309 lobsters were tagged and released from Welker Canyon to the Continental Slope area near Baccaro Bank (Table 1; Fig. 1). The lobsters were caught with baited traps at depths of 50-402 m, using chartered vessels when both male and female lobsters could be tagged and released (Fig. 2). However, commercial lobster boats were used on Corsair Canyon and Browns Bank when mostly berried (ovigerous) females were tagged and released. By law, berried lobsters cannot be retained for commercial use (Fig. 2). The lobsters were tagged and released within 10 min of being brought on board the vessel and within 1 km of the capture area. Two types of tags were used: (1) a "body" tag which consisted of coded polyvinyl

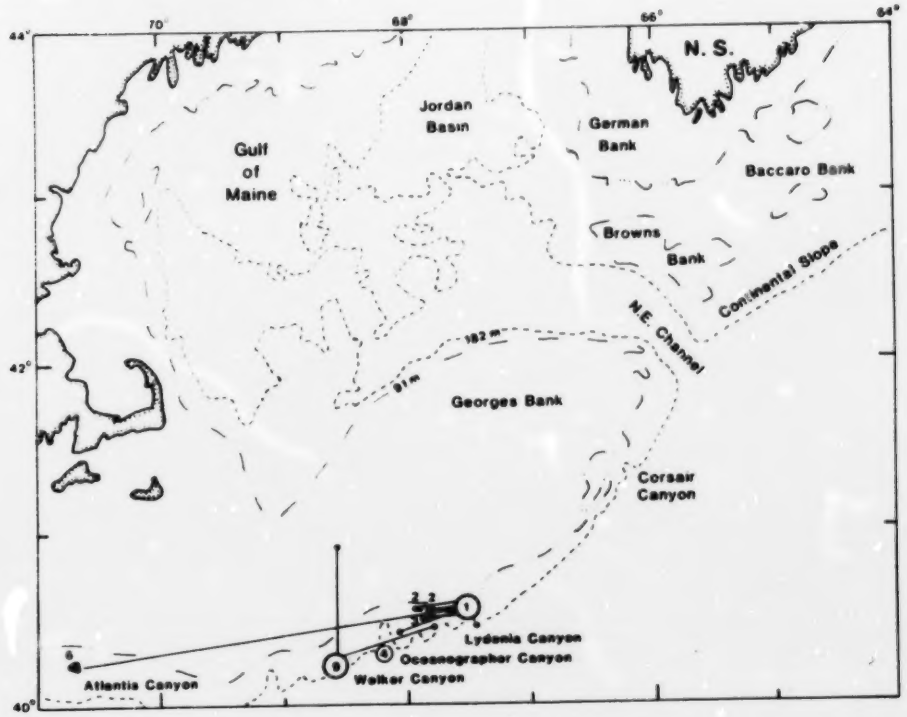

Fig. 1. General release areas and long-distance recoveries of tagged lobsters released from Lydonia to Welker Canyons. One tagged lobster recaptured at location of each dot unless otherwise shown. Numbers in large circles indicate number of recaptures within general areas of release. N.S. = Nova Scotia.

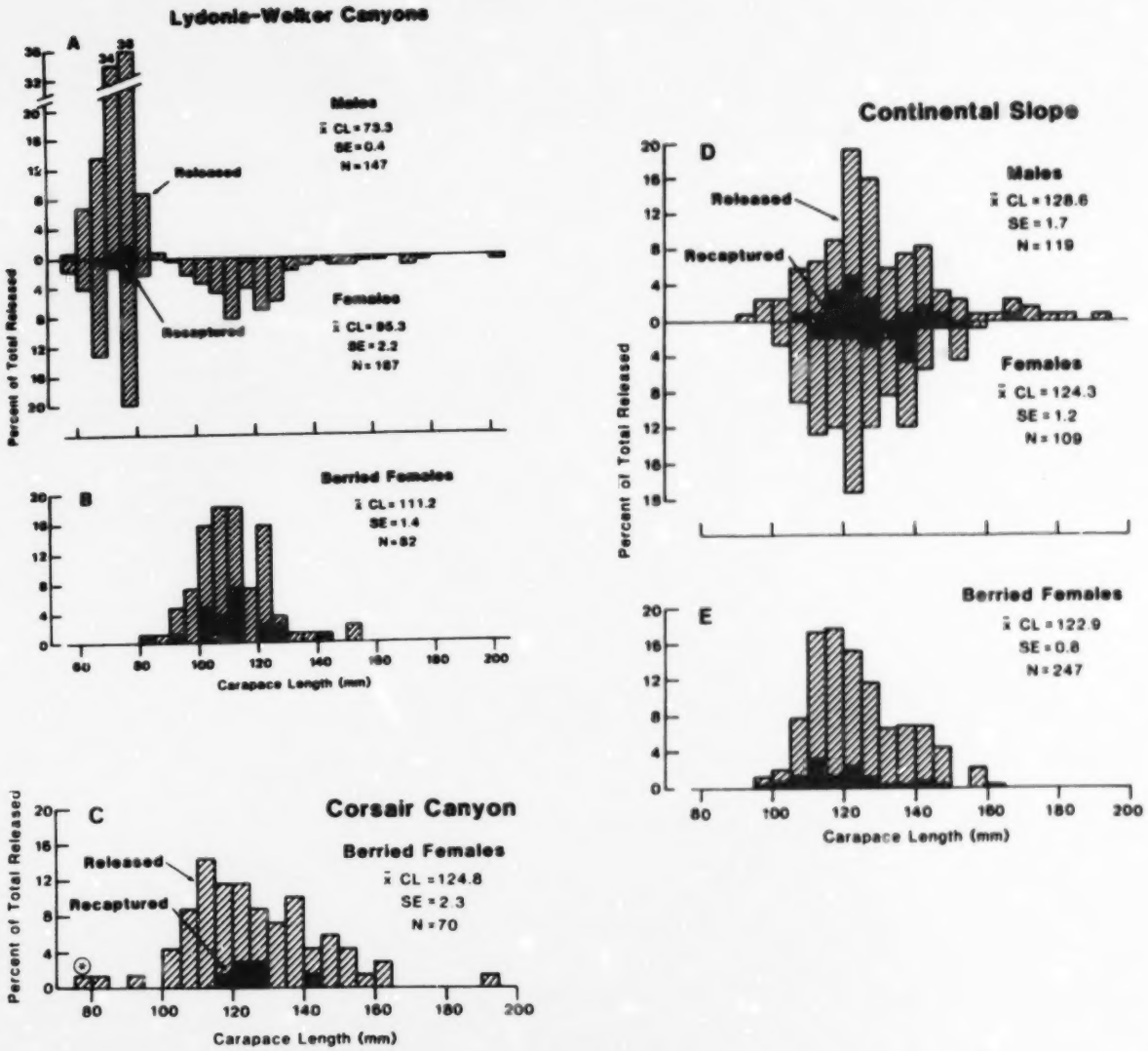

Fig. 2. Size frequencies of tagged male and female (berried and nonberried females kept separate) lobsters released and recaptured for each area of release (A-B) Lydonia - Welker Canyons, (C) Corsair Canyon, (D-E) Continental Slope off Browns Bank and Baccaro Bank, (F-G) Northeastern Georges Bank, (H) Browns Bank. Frequencies expressed as percentages of total tag release. Ⓐ one female at release included. * one male in each size class included. $\bar{X}_{CL}$ = mean carapace length at release, SE = standard error of mean, N = number of individuals. The carapace length and sex of 13 tagged lobsters released in Lydonia-Welker Canyons were not recorded so are not included in Fig. 2A and 2B.

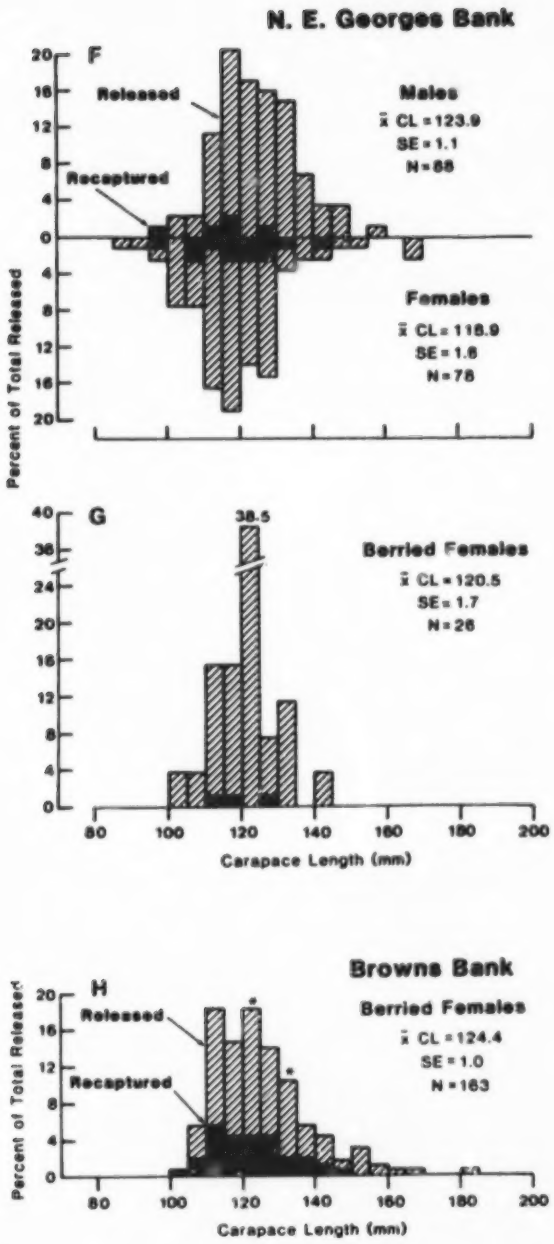

Fig. 2 continued.

chloride tubing tied around the carapace; and (2) a "toggle" tag of coded polyvinyl chloride tubing with a polyethelene monofilament attached to a stainless steel flat toggle (15 x 3 x 0.5 mm, with a hole in the center) anchor implanted in the dorsal musculature between carapace and abdomen (Wilder and Graham 1973). The toggle tag was designed to remain on the lobster through molting, whereas the body tag would be lost during a molt.

Release depth, location, date, size (carapace length, CL) and sex of each lobster were recorded; however, recapture size and sex of most lobsters were not recorded. To ensure the cooperation of fishermen in reporting tag returns with accurate recapture date, location and depth information, a reward of up to $3 was advertised on posters. All captains of Canadian vessels engaged in the offshore lobster fishery were also notified. At about the same period United States lobster fishermen were aware of the tagging programs conducted by Cooper and Uzmann (1971) and Uzmann et al. (1977) so that most Canadian tags recaptured by U.S. fishermen were returned.

All calculations concerned with straight-line distances and direction traveled were determined from the latitude and longitude of release and recapture data (Campbell et al. 1983). The few recapture depths not provided by fishermen were estimated from the recapture latitude and longitude and hydrographic charts. Each recaptured lobster was grouped into one of four classes of distance moved: <18.5 km (0-9 naut mi), 18.5-36.9 km (10-19 naut mi), 37.0-92.6 km (20-50 naut mi), and >92.6 km (>50 naut mi). Each recapture was grouped according to time at liberty into 1.0-yr classes and into four classes of depth at recapture: <91 m (<50 fath), 92-183 m (51-100 fath), 184-274 m (101-150 fath), ≥ 275 m (≥ 151 fath). Twenty-three lobsters had unknown return locations, 24 lobsters had unknown recapture dates and 20 lobsters had unknown recapture depths which could not be used in the movement analyses. Although most (96%) body tags were returned within 1 yr of release, there were no major differences ($p > 0.05$ using one-way analysis of variance, ANOVA after log(x+1) transformation of the data) in distances traveled between lobsters that had body and toggle tags; thus all data from both tag types were combined in the movement analyses for each general release area.

Since seasonal temperature regimes have been correlated with seasonal movements by offshore lobsters to deep-shallow areas (Cooper and Uzmann 1971; Uzmann et al. 1977), recapture depth and distance traveled data were grouped according to recapture date into quarterly periods: 1. January-March; 2. April-June; 3. July-September; 4. October-December. There were no differences ($p > 0.05$ using ANOVA after log(x+1) transformation) between sexes so the data were combined for depth at recapture or distance moved for each quarterly period. The majority of recaptured lobsters were females, berried and/or assumed mature (Aiken and Waddy 1980) (>94 mm CL) (Fig. 2), so no attempt was made to compare the movement data according to mature and immature sizes. There were no significant ($p > 0.05$) correlations between CL and distances traveled after using linear regression analysis; consequently, all sizes were combined for movement analyses.

The statistics of directional movements of the tagged lobsters were analyzed according to Jones (1959) and Saila and Flowers (1968), using a computer program developed by Campbell et al. (1983).

RESULTS

The majority of tagged lobsters released and recaptured were >100 mm CL and, in some areas (e.g. Corsair Canyon and Browns Bank), mostly berried females were released (Fig. 2). Only in the Lydonia-Welker Canyon releases were lobsters in the 55-80 mm CL range. Of the 1309 tagged lobsters released, 13.2% were recaptured but only 11.1% had sufficient recapture information to be used for the movement analyses (Table 1). Only 8.2% of the body tags were recovered compared to 18.4% of the toggle tags, reflecting the longer lasting design of the toggle tags (Table 1). Most (71.8%) tags were recaptured within 1 yr of release and the percentage of returns decreased with increased time at liberty to 1.3% of total recaptures at 8-9 yr (Table 2). The longest time at liberty recorded was 8.4 yr for a female released on NE Georges Bank, July 1972, and recaptured 166.8 km from release during December 1980 (Table 2). There were no differences ($p>0.05$) between males and females in mean time at liberty for each area of release except for Lydonia-Welker Canyons (Table 2). The overall average time (all areas combined) between release and recapture was greater ($0.01< p<0.05$) for females than males (Table 2). This difference may be a reflection of sample size bias more than a true biological phenomenon since the larger number of female releases would have increased the probability of capturing females for a longer period than males.

Of the 150 lobsters for which recapture locations were known, 42.0% were caught <18.5 km and 12.7% were caught >92.6 km from the release areas (Table 3). There were no differences ($p > 0.05$) in mean distances traveled between males and females for each area of release (Table 3). There was a general trend for lobsters to be recaptured at greater distances from release sites with increasing time at liberty although some lobsters were caught relatively close to the release sites after long periods at liberty (Fig. 3). In this study, the greatest straight-line distance moved between release and recapture was 346.9 km for a female (117 mm CL at release) that traveled from the Continental Slope near Browns Bank to slightly east of Welker Canyon (Table 3, Fig. 4).

Examination of the straight-line tracks between release and recapture points indicates that some lobsters are capable of extensive movements (Fig. 1-7). Eight lobsters crossed the northeast channel between Browns and Georges Banks. One female crossed NE Georges Bank and was captured in the inshore areas of SW Nova Scotia 8.4 yr after release (Fig. 5). Some tags were captured as far west as near Atlantis Canyon (Fig. 1). Most long-distance-moving lobsters were recaptured near or on the slopes of the Continental Shelf. In general, direction of movement of returns was west and south. Direction statistics were computed on a quarterly period and total basis for all tagged lobsters that were recaptured (Table 4). The mean vector angle, $\bar{\theta}$, for all areas combined, was 247.5° from true north with larger values for V' than V, suggesting greater westerly than southerly movements (Table 4). The Rayleigh tests indicated a non-uniform distribution for returns analyzed (Table 4). The directional statistics grouped by quarterly periods

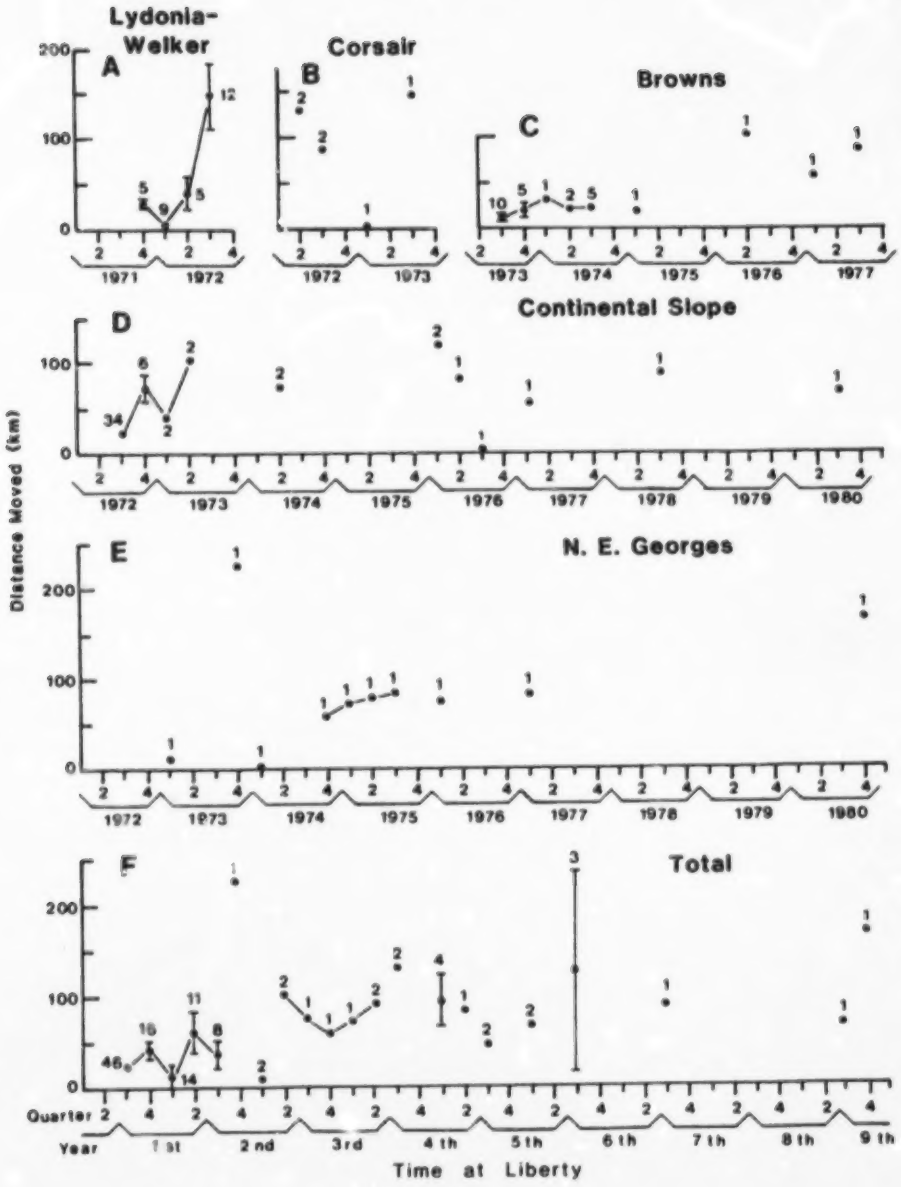

Fig. 3. Mean straight-line distances moved (km) for tagged lobsters recaptured grouped by quarterly periods for release areas (A) Lydonia - Welker Canyons, (B) Corsair Canyon, (C) Browns Bank, (D) Continental Slope off Browns Bank and Baccaro Bank, (E) Northeastern Georges Bank, (F) total of all areas combined. Dots = means, vertical lines = ±1 SE, number by each dot = number of individuals recaptured.

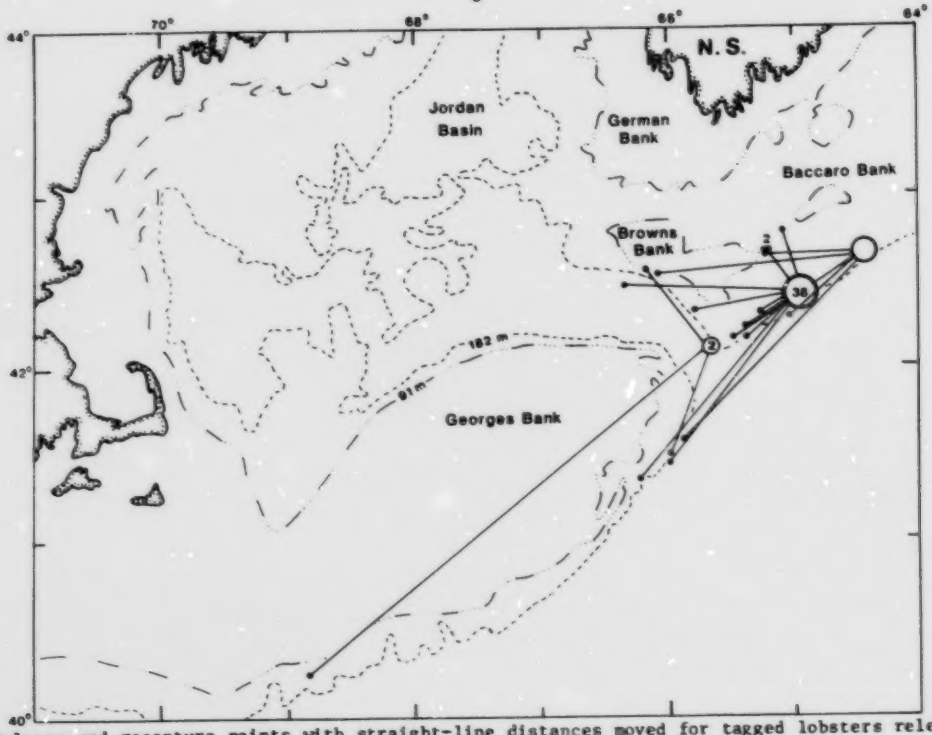

Fig. 4. Release and recapture points with straight-line distances moved for tagged lobsters released along the Continental Slope near Browns Bank and Baccaro Bank. One tagged lobster recapture at location of each dot unless otherwise shown. Numbers in large circles indicate number of recaptures within general areas of release.

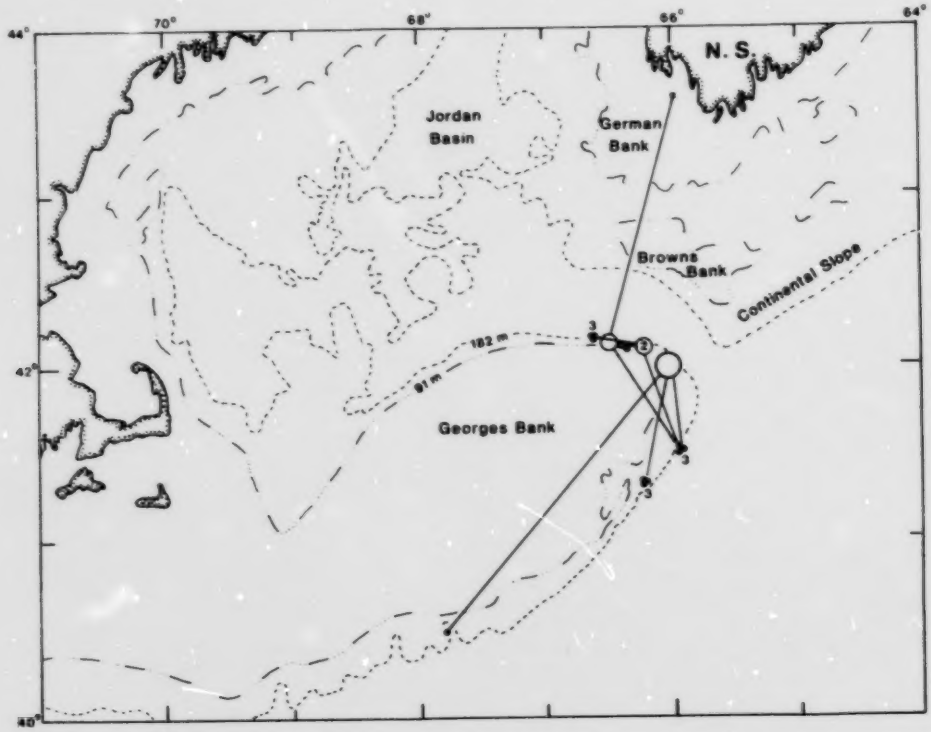

Fig. 5. Release and recapture points with straight-line distances moved for tagged lobsters released along the Northeastern Georges Bank. One tagged lobster recapture at location of each dot unless otherwise shown. Numbers in large circles indicate number of recaptures within general areas of release.

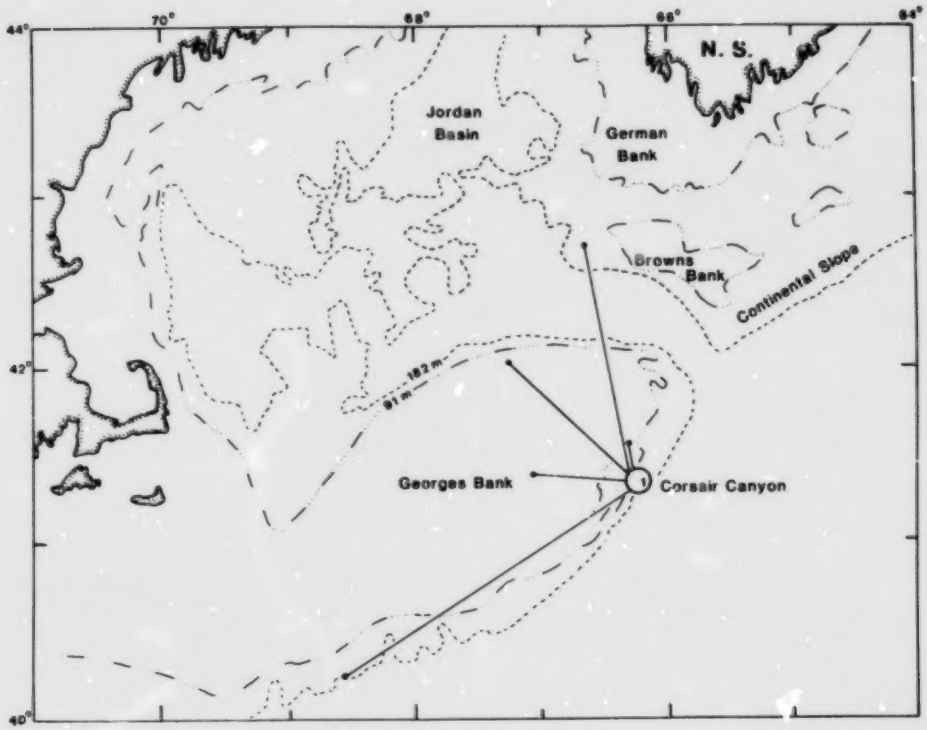

Fig. 6. Release and recapture points with straight-line distances moved for tagged lobsters released along the Corsair Canyon. One tagged lobster recapture at location of each dot unless otherwise shown. Numbers in large circles indicate number of recaptures within general areas of release.

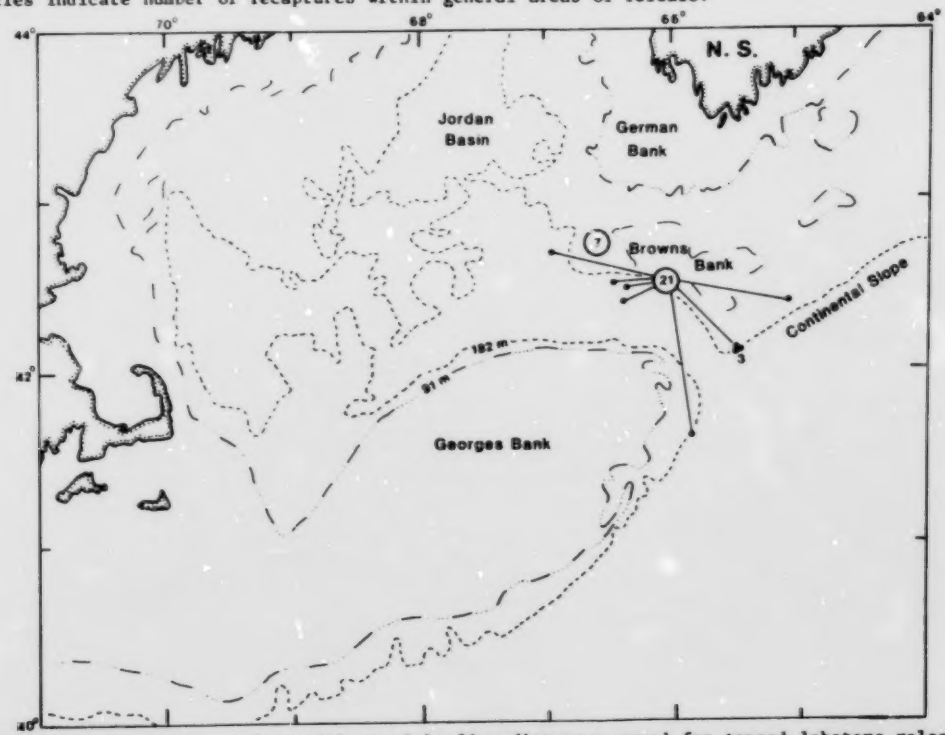

Fig. 7. Release and recapture points with straight-line distances moved for tagged lobsters released along the Browns Bank. One tagged lobster recapture at location of each dot unless otherwise shown. Numbers in large circles indicate number of recaptures within general areas of release.

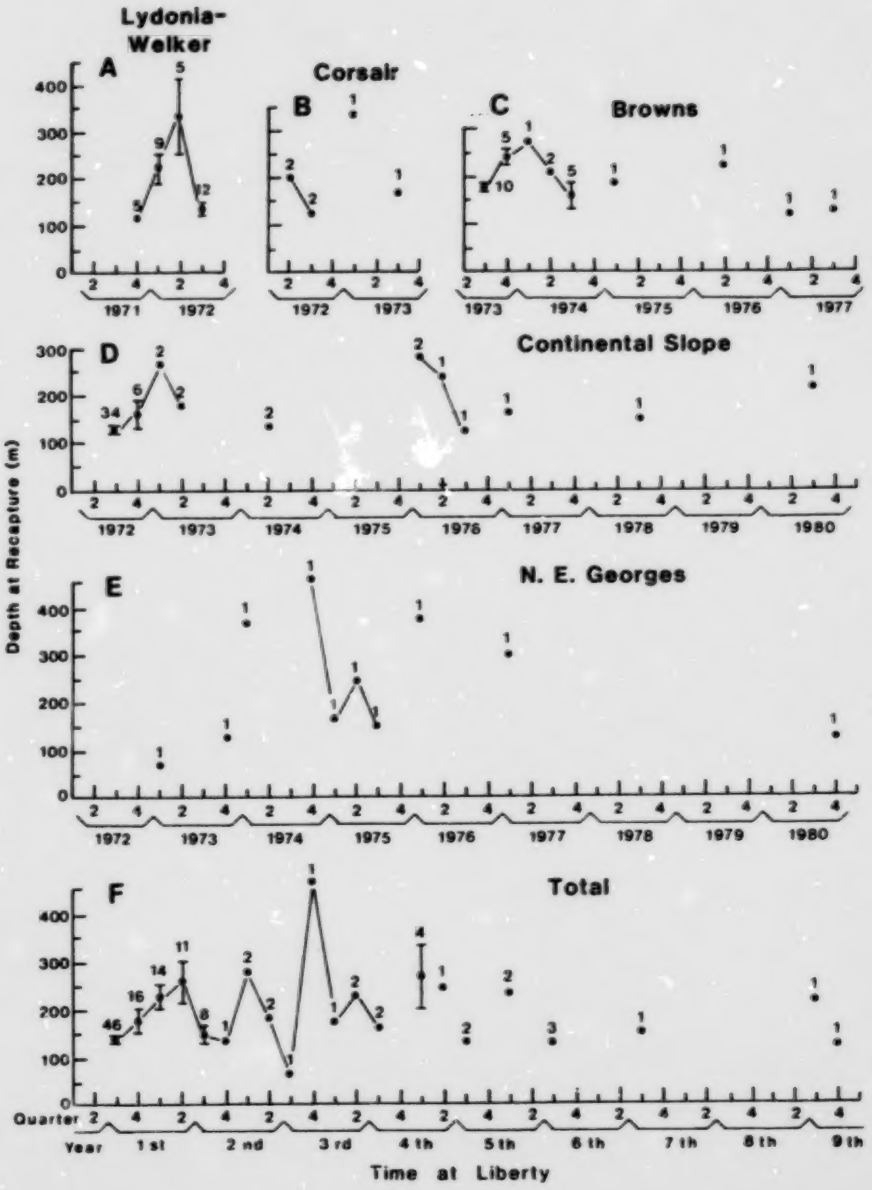

Fig. 8. Mean depth (m) at recapture of tagged lobsters grouped by quarterly periods for release areas (A) Lydonia - Welker Canyons, (B) Corsair Canyon, (C) Browns Bank, (D) Continental Slope off Browns Bank and Baccaro Bank, (E) northeastern Georges Bank, (F) total of all areas combined. Dots = means, vertical lines = ±1 SE, number by each dot = number of individuals recaptured.

were difficult to interpret, because of the insufficient number of recaptures representing each quarterly period for each area of release. Overall, the mean square dispersion values, a^2, were high, but variable and difficult to interpret. High a^2 values may indicate random dispersal, although these values could be overestimated when there are substantial directional movements and the times at large are short (Jones 1959).

There were no differences between males and females in mean depths at recapture (Table 5). The deepest recapture was 457 m for a female. During the first 2 yr after release there are indications of seasonal changes in mean depths of recapture (Fig. 8). The deepest mean depths of recapture were during the first and/or second quarter of each year in each area; the shallowest were during the third and/or fourth quarter (Fig. 8).

DISCUSSION

Interpretation of the movement data in this study should be made with caution since the recapture numbers were small. The simple estimation of straight-line movement from single release-recapture and time-at-liberty data seldom provides an accurate picture of the exact movements of tagged lobsters. Although simplistic, the straight-line movement estimation is useful in providing a general overview of short- and long-term dispersal rates of lobsters. The monitoring of long-term movements with the body tag is limited since the tag is lost at molting. Large mature lobsters may not molt every year but once every $\geq$2 yr (Aiken 1980; Cooper and Uzmann 1980; Campbell 1983). Also the non-uniform distribution of fishing effort may bias the samples by causing an apparent directional component to an otherwise possible randomness of lobster movement. Fishing effort for lobsters in offshore areas off southwestern Nova Scotia has increased since the beginning of the Canadian offshore lobster fishery in 1971 (Pezzack and Duggan 1983). However, the distribution of recaptured tagged lobsters is probably representative of the offshore lobster population distribucion since fishermen search for commercial quantities of lobsters throughout most of the year (Uzmann et al. 1977; Pezzack and Duggan 1983). Despite the possible shortcomings of the data of the present report, some useful information can be extracted and comparisons with other lobster tagging studies made.

One major finding of this study is that offshore lobsters are capable of long-distance movement. Despite the majority of recaptures are within the first year of release, the mean distance moved was 50.9 km for all lobsters recaptured with 42.0% caught within 18.5 km of the release site. This is in contrast to data for mostly immature lobsters tagged in inshore areas such as Port Maitland when most (95.4%) were recaptured $<$18.5 km of the release area (Campbell 1982). Many other tagging studies on the American lobster in inshore areas have indicated generally localized movements for both sexes (Wilder and Murray 1958; Wilder 1963; Squires and Ennis 1968; Fogarty et al. 1980; Krouse 1980, 1981; Stasko 1980). However, large, sexually mature lobsters have been shown to move long distances, especially on offshore areas of the New England Continental Shelf (Saila and Flowers 1968; Cooper and Uzmann 1971) and in the Gulf of Maine and Bay of Fundy (Krouse 1980; Campbell 1984; Campbell and Mohn 1982).

In this study, the general west-south direction of dispersal is difficult to interpret. This apparent mean directional movement may be an artifact due to the small sample size or to higher fishing intensity by the U.S. fleet and a new (during early 1970's) Canadian lobster fleet fishing more on Georges Bank and further west than the offshore areas near Nova Scotia. In addition, many of the lobsters were caught on or near the slopes of the Continental Shelf which is in agreement with Cooper and Uzmann (1971, 1980) and Uzmann et al. (1977) who found a tendency for some lobsters to move laterally east and west along the outer shelf and upper slope.

The trend shown in this study, for lobsters to move seasonally to shallow waters in the summer months and deep waters in winter months, supports the findings of Cooper and Uzmann (1971) and Uzmann et al. (1977). They found that the seasonal distribution of tagged lobsters was positively correlated with bottom temperatures so that the offshore lobster population maintained itself within a temperature range of 8-14°C. They hypothesized that the shoalward movement towards warmer waters in the summer months provided sufficiently high temperatures to optimize the physiological requirements of molting and egg extrusion. However, the large variation in recapture depths by month suggested that the shoalward dispersal during summer was not a coordinated phenomenon and, as noted above, there was also a tendency for lobsters to move laterally along the Continental Slope from one canyon to another (Cooper and Uzmann 1980).

The long-distance movement of offshore lobsters described in our study indicates intermixing of lobsters along the Continental Shelf of this area. This supports the hypothesis that there may be a common stock of lobsters in the Gulf of Maine and the adjoining Continental Shelf (Campbell and Mohn 1982, 1983).

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Table 1. Summary of lobster tagging on the Continental Shelf, 1971-73.

General area	Release Date	Depth range m	Tag type	Number	Recapture Number	Recapture % of total releases
Lydonia Canyon	17-29 Sept. 1971	100-133	Body	153[a]	18	11.8
Welker Canyon	10-18 Jan. 1972	91-293	Body	256[a]	15	5.9
Corsair Canyon	18-27 April 1972	137-402	Body	24	1	4.2
			Toggle	46	5	10.9
Continental Slope	27 June - 4 July 1972	128-137	Body	180	18	10.0
			Toggle	19	5	26.3
	10 July - 10 Aug. 1972	119-182	Body	24	3	12.5
			Toggle	252	44	17.5
NE Georges Bank	21-22 July 1972	91-182	Body	31	0	0
			Toggle	161	20	12.4
Browns Bank	30 June - 4 July 1973	50-100	Toggle	163	44	27.0
Total for all areas	1971-1973	51-402	Body	668	55	8.2
			Toggle	641	118	18.4
			Total	1309	173[b]	13.2

[a] 13 tags released with unknown locations.
[b] 23 tags recaptured with unknown locations.

Table 2. Percentage of total recaptures and mean years at liberty of lobsters tagged on the Continental Shelf, 1971-73; includes some lobsters without recapture location data. (M = male, F = female, B = berried females, T = total, U = unkown sex).

Sex at release	Years at liberty 0-1 %	1-2 %	2-3 %	3-4 %	4-5 %	5-6 %	6-7 %	8-9 %	Arithmetic mean	Geometric mean	Maximum	Total recapture known	(unknown) dates
Lydonia - Welker Canyons													
U													(1)
M	100.0								0.04	0.04[a]	0.05	3	
F	100.0								0.46	0.27[b]	0.91	28	(1)
T	100.0								0.42	0.22	0.91	31	(2)
Corsair Canyon													
T(B)	83.3	16.7							0.51	0.32	1.43	6	
Continental Slope													
M	88.2	5.9	5.9						0.42	0.19[a]	2.51	17	(3)
F	70.8	6.3		8.3	4.1	6.3	2.1	2.1	1.34	0.40[a]	8.18	48	(2)
T	75.4	6.2	1.5	6.2	3.1	4.6	1.5	1.5	1.10	0.33	8.18	65	(5)
NE Georges Bank													
M		75.0			25.0				2.30	1.98[a]	4.57	4	(1)
F	18.2	18.2	36.3	9.1	9.1			9.1	2.79	2.01[a]	8.43	11	(4)
T	13.4	33.2	26.7	6.7	13.3			6.7	2.66	2.01	8.43	15	(5)
Browns Bank													
F(B)	53.1[c]	18.8	9.4	6.2	3.1				1.00	0.43	4.03	32[c]	(12)
Total for all areas													
U													(1)
M	76.0	16.0	4.0		4.0				0.66	0.21[a]	4.57	25	(4)
F	70.9	9.7	5.7	5.7	3.2	2.4	0.8	1.6	1.15	0.43[b]	8.43	124	(19)
T	71.8	10.7	5.4	4.7	3.4	2.0	0.7	1.3	1.07	0.38	8.43	149	(24)

[a,b]Means followed by same letter for male and female for each area only not different ($p>0.05$), means followed by different letters are significantly different ($p<0.05$) using one-way ANOVA after log(x) transformation.

[c]Includes one male.

Table 3. Percentage of totals and means of straight-line distance traveled by lobsters tagged on the Continental Shelf, 1971-73; includes some lobsters with unknown times at liberty (i.e. no recapture dates). (M = male, F = female, B = berried female, T = total, U = unknown sex).

Sex at Release	Distance moved (km) <18.5 %	18.5-36.9 %	37.0-92.6 %	>92.6 %	Arithmetic mean	Geometric mean	Maximum	Total recaptures known	(unknown) distance moved
Lydonia - Welker Canyons									
U									(1)
M	66.7	33.3			6.9	1.8[a]	20.6	3	
F	53.6	10.7	14.3	21.4	75.7	19.7[a]	270.4	28	(1)
T	54.8	12.9	12.9	19.4	69.0	16.0	270.4	31	(2)
Corsair Canyon									
T(B)	16.6	16.7	16.7	50.0	97.5	43.0	233.9	6	
Continental Slope									
M	23.5	29.4	47.1		40.0	33.2[a]	85.9	17	(3)
F	40.9	18.2	25.0	15.9	54.0	30.7[b]	346.9	44	(6)
T	36.1	21.3	31.1	11.5	50.1	31.4	346.9	61	(9)
NE Georges Bank									
M		50.0	50.0		55.6	48.4[a]	83.2	2	(3)
F	16.7	25.0	41.6	16.7	71.5	40.8[a]	225.7	12	(3)
T	14.3	28.6	42.8	14.3	69.2	41.8	225.7	14	(6)
Browns Bank									
T(B)	55.3[b]	28.9	13.2	2.6	23.4	9.4	103.2	38[b]	(6)
Total for all areas									
U									(1)
M	30.4	30.4	39.2	0	35.2	20.9[a]	85.9	23	(6)
F	44.1	20.5	20.5	14.9	53.8	21.2[a]	346.9	127	(16)
T	42.0	22.0	23.3	12.7	50.9	21.1	346.9	150	(23)

[a]Means followed by same letter for male and female in each area only not different ($p>0.05$) using ANOVA after log(x+1) transformation.
[b]Includes one male.

Table 4. Direction statistics for tagged lobsters recaptured on the Continental Shelf (released 1971-73). $\bar{\theta}$ = mean vector angle from true north; a^2 = mean square dispersion coefficient is a measure of random movements; V and V' = non-random directed movement along north-south and east-west plane, respectively, negative values of V and V' indicate net southerly and westerly movement, respectively; R and $\bar{R}$ = Rayleigh test statistics for randomness of uniform distribution of points about a circle; N = number of individuals; ** = significant at $p < 0.01$ and * significant at $p < 0.05$ indicate a non-uniform distribution (Batschalet 1965). Both sexes combined; only first four quarters shown when $N \geq 2$; total includes recaptures for all years that have exact dates and locations of release and recapture.

Year	Quarter	$\bar{\theta}$	a^2_2 (km^2/d)	V (km/d)	V' (km/d)	R	$\bar{R}$	N
Lydonia - Welker Canyons								
1971	4	263.1	17.8	-0.076	-0.633	4.98	4.97**	5
1972	1	193.7	3.9	-0.130	-0.032	4.22	1.98	9
	2	207.1	13.7	-0.051	-0.026	2.07	0.85	5
	3	264.6	112.1	-0.045	-0.479	9.04	6.81**	12
Total		262.2	49.6	-0.052	-0.383	14.23	6.53**	31
Corsair Canyon								
1972	2	245.1	962.4	-1.164	-2.508	1.33	0.89	2
	3	296.7	58.1	0.341	-0.680	1.88	1.77	2
Total		287.7	368.2	0.110	-0.346	4.43	3.27	6
Continental Slope								
1972	3	230.4	20.3	-0.172	-0.208	8.48	2.11	34
	4	223.2	36.4	-0.358	-0.336	3.78	2.38	6
1973	1	63.4	9.3	0.037	0.074	0.15	0.01	2
	2	284.6	37.2	0.083	-0.321	1.86	1.72	2
Total		238.4	22.0	-0.042	-0.069	20.67	7.50**	57
NE Georges Bank								
Total		183.6	12.9	-0.039	-0.002	4.90	2.41	10
Browns Bank								
1973	3	311.5	1.7	0.116	-0.131	8.19	6.72**	10
	4	258.5	3.5	-0.026	-0.131	3.42	2.34	5
Total		239.8	2.8	-0.011	-0.019	11.64	5.01**	28
Total for all areas								
Total		247.5	39.7	-0.033	-0.081	42.16	13.46**	132

Table 5. Percentage of totals and means of depth at recapture for lobsters tagged on the Continental Shelf, 1971-73; includes some lobsters with unknown times at liberty (i.e. no recapture dates) and location of recapture. (M = male, F = female, B = berried female, T = total, U = unknown sex).

Sex at release	Depth (m) at recapture ≤91 %	92-183 %	184-274 %	≥275 %	Arithmetic mean	Geometric mean	Maximum	Total recaptures known	(unknown) depth
Lydonia - Welker Canyons									
U									(1)
M	0	33.3	66.7	0	183	181[a]	201	3	
F	3.6	64.3	17.9	14.2	185	160[a]	457	28	(1)
T	3.2	61.3	22.6	12.9	185	162	457	31	(2)
Corsair Canyon									
T(B)	33.4	33.3		33.3	185	86	329	6	
Continental Slope									
M	0	94.4	5.6	0	135	132[a]	256	18	(2)
F	2.3	79.5	15.9	2.3	150	140[a]	366	44	(6)
T	1.6	83.9	12.9	1.6	146	138	366	62	(8)
NE Georges Bank									
M		50.0		50.0	233	226[a]	293	2	(3)
F	7.7	53.8	15.4	23.1	215	190[a]	457	13	(2)
T	6.7	53.3	13.3	26.7	217	194	457	15	(5)
Browns Bank									
F(B)	5.1	64.1[b]	30.8		180	173	267	39[b]	(5)
Total for all areas									
U									(1)
M		83.3	12.5	4.2	150	145[a]	293	24	(5)
F	5.4	66.7	20.2	7.7	175	159[a]	457	129	(14)
T	4.5	69.3	18.9	7.3	171	157	457	153	(20)

[a]Means followed by same letter for male and female in each area only not different ($p>0.05$) using ANOVA after log(x+1) transformation.
[b]Includes one male.